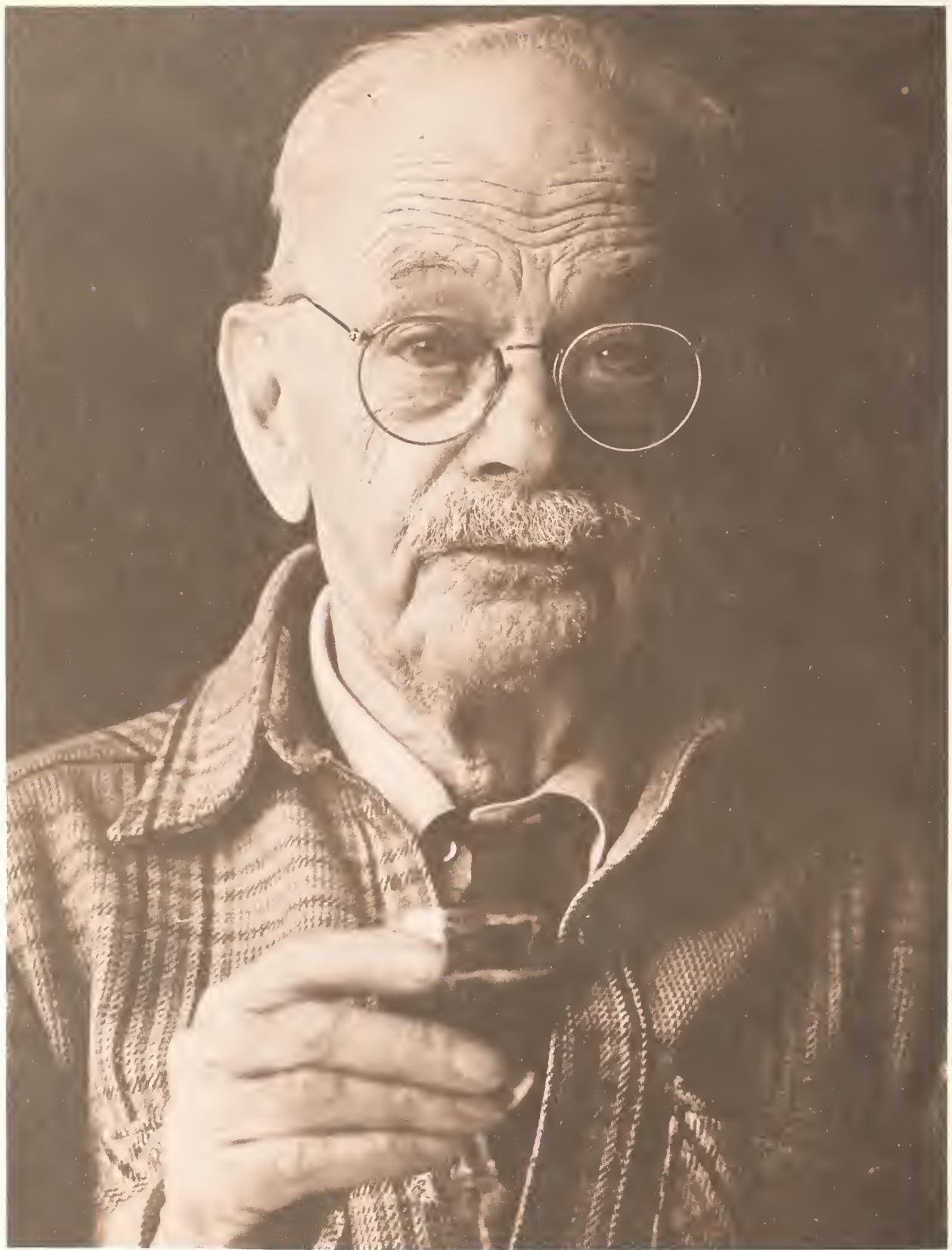


Changes

**... research on aging
and the aged**

U.S. DEPARTMENT OF HEALTH
AND HUMAN SERVICES
Public Health Service
National Institutes of Health



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on aging
and the aged

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*This sweeping away of fetishes
and illusions is the truest,
most worthwhile
of all the contributions
brought on by age.*

SIMONE DE BEAUVIOR in *The
Coming of Age*

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Foreword

We should all be concerned about the future because we will have to spend the rest of our lives there.

CHARLES F. KETTERING

Looking back on one's life is a remarkable experience, even if the view is sometimes clouded by bittersweet memories. However difficult the retrospection, patterns can emerge, revelatory and exciting.

How the elderly go about examining their lives is not up to society; each person must find his own way. But neither should society make the way harder; rather, it should ensure that the old have a setting in which to reflect carefully on what has happened to them. The Federal Government, as a repository of the political and economic will of society, is a major instrument for meeting this societal obligation. Congress clearly recognized society's responsibilities toward the elderly when it passed in 1974 the National Research on Aging Act, which created the National Institute on Aging.

Society's obligation to care for its own has not fully been met in the case of the elderly. Health care systems, by and large, are attuned to acute, episodic care rather than to the chronic, often multiple problems faced by people as they grow old. Social services—for example, in transportation, housing, and financial support—are fragmented, often underfunded, invariably insufficient. Long-term care institutions are perceived by many, on

good evidence, as signposts to decline and death rather than recuperation. And there is the inadequate, if not completely absent, help for the primary caretakers of the dependent aged in the United States—their families.

Life expectancies from birth and, less so, from age 65 have been increased; but for many of the aged the extension is simply an extension of disease, of diminished quality of life. Our approaches to caring for the aged have tended to the extremes: too little care or too much, with over-medicated and overbedded patients ending their lives in institutions.

Underlying these particulars are subtler, more intractable attitudes—our fear of growing old, our belief that senility and disease are inevitable.

The National Institute on Aging is a young Institute with a formidable agenda. Some of its concerns, approaches, and interests are given in this publication. The issues of aging and the aged are so diverse, so intertwined, and so much a part of the dynamic structure and mores of U.S. society that the Institute can only hope to make a good beginning. Its primary goal is not the prolongation of life, but its betterment; its essential mission is to frame critical questions and to seek answers—through its own research and through its support of the training and research of able men and women. The intent, as stated in the title of this publication, is to explore the changes that occur with age and to help all of us understand that these changes are not inevitably associated with decline; they can also be enriching, freeing us to find new and valuable perceptions of ourselves and the world about us.

ROBERT N. BUTLER, MD
Director, National Institute on Aging



And therefore if a man lives many years, let him enjoy all of them.

ECCELESIASTES



Perspectives on Research

The United States is not alone in searching for more effective ways to serve its aged. In 1972, the World Health Organization pointed out that the increased proportion of the aged in the populations of the developed countries would "weaken seriously the capacity of populations to look after old people in the traditional ways and make the development of new methods of care necessary." Demographic pressures have only intensified since then. Some 23 million people in the United States (almost 11 percent of the population) are age 65 and over; by 2030, according to the U.S. Bureau of the Census, the elderly population may be almost 55 million, or 14 to 22 percent of the population, depending on future fertility levels (Figure 1). Furthermore, the expectations of persons now approaching old age are different from those of the present elderly*; the

future elderly will be generally better educated, more affluent, and more accustomed to regarding social services and support as rights.

These pressures merge with others: for example, the need to control national health care costs and the related efforts to create a national system of health insurance. Nursing home care has become an important component of overall health costs, reaching \$7.7 billion in 1975 for nursing home care for the elderly. Relying upon both general revenues and trust funds paid in by the working population, including current retirees, governments at all levels now pay \$20 billion annually for personal health care of the elderly.

These figures confirm society's increased willingness to assume responsibility for the care of its aged. At the same time, society requires the assurance that public funds are effectively applied and the aged well served.

*Throughout this brochure, "elderly," "aged," and "old" mean age 65 and over.

It requires a firm understanding of the physical and mental health problems of the aged. How do biological changes associated with age relate to the expression of disease? Indeed, what are the biological changes that occur with age? While many of them are known, we are still learning about others: changes in the body's immunological system, changes in molecular events occurring within cells, changes in the nervous system, in the muscles, and in the structure of bone. Moreover, this new knowledge must be applied to clinical procedures—to diagnosis, particularly of diseases whose signs reflect changes caused by aging; to treatment, including the prescription of drugs that may affect the elderly differently than the young; and to the expectation of cure, the plain fact being that, with the illnesses of the aged, the emphasis is as likely to be on *management* as on cure.

Research has already given us valuable insights. For example, we can more clearly differentiate between functional disorders such as depression and organic brain syndromes caused by a physical illness or drug intoxication. We understand better the relationship of physical ailments, such as diabetes mellitus or cerebral arteriosclerosis, to signs of mental disturbance, such as confusion; therefore, diagnosis is more accurate and treatment more effective.

Further research efforts are needed to deal adequately with illness. What sorts of services are needed; should they be separate from other services or part of an integrated program? How can health workers—for example, nurses, physical therapists, mental health workers—become as attuned to the needs of the elderly as they are to the needs of their younger patients? Can more effective diagnostic tests be devised—tests that allow for shorter attention spans, slower assimila-

tion of new or strange information, and other apparent changes in mental abilities that may occur with age?

On another plane, deep dissatisfaction with institutional care for the elderly, particularly with nursing home care, has spurred the search for alternatives. The quality of institutional care is often poor, and it is difficult and expensive to monitor. Institutionalization can prematurely, even unnecessarily deprive the elderly of the social, familial, and community contacts basic to a person's well-being and sense of worth.

Alternatives to institutional care already exist, since some 95 percent of the elderly population are not in institutions, but either care for themselves—the usual situation—or are cared for by their families or close friends. These alternatives are in part supported by an income policy—social security; supplemental security income, based on a minimum income level; federally financed Medicare; and Medicaid, based on need and financed by both state and federal governments. But how does an income policy help the family support both its elderly and its children? What of the three to four million individuals—some 14 to 17 percent of those over age 65—who cannot fully care for themselves? How does current policy meet the needs of this population?

These are policy issues reliant on an understanding of the needs of the aged, not only now but in the future. Policy formulation is *not* the responsibility of the National Institute on Aging (NIA). But the NIA, along with other groups and agencies, is seeking to uncover many of the facts and to find the understandings on which policies must be based. Knowledge will evolve not only from analyses of the costs of alternative programs, but also from the study of the abilities, attitudes, and needs of different



groups of the elderly: their capacities for self-care; the nature of their chronic disabilities; their perception of various policies as earned support or as public charity; and their dependence—on each other, on their communities, on private and public pensions.

Goals

Aging is a normal part of human development. Therefore the responsibilities and aims of the NIA differ somewhat from those of the units of the National Institutes of Health concerned with specific illnesses such as heart disease, cancer, and infectious and neurological diseases. Progress in understanding these and other diseases is as important to the aged as it is to other Americans; and is essential to the mission of the NIA. But the NIA's mission encompasses more than the problems of illness and disease per se. The NIA is concerned with the environment in which the aged do and will live. Its goal is to provide the understanding needed to structure effective policies, to plan effectively for the future, to enable both society and the elderly to make optimum use of national resources, and, above all, to enrich the lives of the elderly.

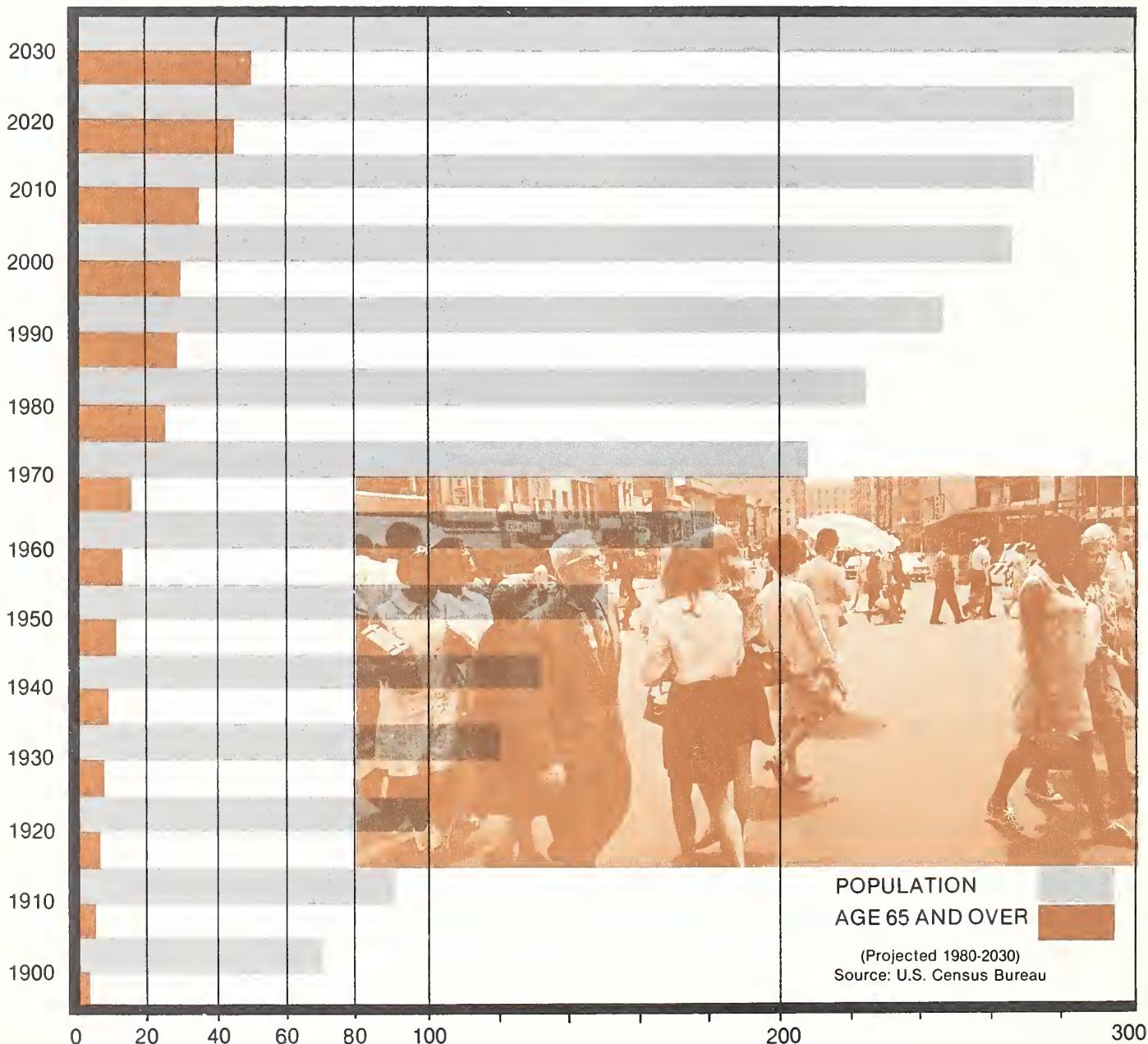
The Aged in the 20th Century

The diseases of the aged, the quality of their lives, their ability and willingness to care for themselves, their capacity to cope with stress—all these are shaped not only by individual histories, such as heredity and early family life, but also by the society in which the aged lived. What were work conditions like? What was family life like? What social services were provided? Were there economic calamities, such as a severe depression?

Certainly, the milieu of today's aged is quite different from that of the aged in 1900. There were fewer aged then, both in absolute numbers and as a percentage of the total population: four percent in 1900 (3 million), 10.9 percent in 1976 (23 million). Ten percent of the aged lived alone in 1900; 25 percent in 1970. Work was usually a lifetime affair in 1900, with formal retirement and a pension an oddity. Today, work is more a stage of life, one that is increasingly entered at an older age and left at a younger one. One pension (social security) is now usual, with two pensions per retiree becoming more frequent. The aged today are better educated. By 1960, about ten percent of the aged had finished four years of high school, and by 1970, 20 percent; the figures for four years of college are 3.7 percent and 7.6 percent, respectively.

Less quantifiable changes have occurred. The belief that the aged are the fittest survivors and the mystique of old age as a time when cares are gone were shattered early in the 20th century as the realities of the lives of many of the aged became more widely known. Desperate poverty was often the reward of a lifetime of labor, since there were no pensions and no room for elderly workers in an increasingly efficiency-con-

GROWTH CHART—Bars show the number of persons age 65 and older compared with total population from 1900. The chart extends to the year 2030.



scious industrial society. Illnesses often went untreated because the aged could not afford to pay, because illness was considered inevitable in old age, or because the medical professions preferred to treat the problems of younger people.

With public support perceived as charity, with poorhouses and homes for the aged usually perceived as nothing more than warehouses for the unfit, the aged and the dying, with steady employment uncertain, and often with parents and older children all working, the family was essential for survival. Grandparents, parents, and children assumed various roles in assuring the integrity and well-being of the family. The elderly maintained their property rights, in part as insurance that they would always be cared for. There was no clear distinction between family life and work, no formal retirement age.

The elderly today reflect different experiences. Various centrifugal forces on the family—social legislation giving individuals more independence, greater mobility, more emphasis within the family on raising children, more mothers working—have distorted the traditional interdependencies between the elderly and their children and grandchildren. The depression left its economic and psychological scars. A lifetime of relatively low earnings now shows up as relatively low pensions for many of the elderly. And life expectancies for men and women have changed—today most elderly women are likely to be widows.

Any effort to understand and deal with the problems of the aged must include these and other elements of their background. Similarly, research intended to help shape future policies and strengthen current ones must consider changes now occurring in U.S. society. The family today is radically different

from what it was 25 years ago, and there is evidence of further forces for change. For example, single-parent families have become a significant phenomenon: one of six children under 18 lives in a single-parent home. The number of adults per household (including those with no children) dropped in 1975 to an average of two. The proportion of families living with a relative such as a grandparent (extended families) has dropped appreciably in the last 25 years. And the majority of mothers now work or seek work when their children reach school age.

These facts are being interpreted by some students of family life as symptomatic of a long-term decline in relationships between parents and children—parents more involved in work or community activities, and children placed in group settings, formal and informal. Whatever the interpretations, what will be the effects of these changes on people—both parents and children—as they age? How will they as elderly adults cope with stresses, with chronic illnesses? What problems will they have that are not evident now among the elderly?

The needs and demands of the future aged will be different from those of today's aged. But we are uncertain of what those differences will be. Many of the future aged will be better educated. Their social security pensions, increasingly supplemented by a second pension, should enable them to sustain a tolerable standard of living, although paradoxically the gap between their employment earnings and their pensions may be greater than it is for many of today's aged.

In all, an understanding of the terrain in which the aged have lived and are living is needed if the NIA is to perform its task of providing the information and insights needed by society to optimally serve its current and future aged.

Research Issues I Disease and Aging

The goal of researchers in aging, including those at the NIA, is to lengthen the useful and active lives of the elderly and to improve the quality of their lives. Essential to that goal is an accurate portrayal of the health problems of the aged: which physical and mental illnesses are usual for different subgroups of the aged; which changes are due to aging and which to disease, as well as their effects upon each other; and to what degree the elderly can cope with their chronic diseases, given effective support.

About a quarter of the diseases of the elderly are infectious. The remainder are typically chronic, multipathological (a composite of several problems), and—in their symptoms, course, and treatability—affected by changes that occur normally with age.

Chronic illnesses often demand an attitude of caring rather than curing, concern with the environment in which the patient lives, and the acceptance by both patient and

physician of the limitations of medicine.

The NIA intends to improve the understanding of acute and chronic diseases and their interplay with the processes of aging, thereby helping the treating physician to make more certain diagnoses and to provide more effective treatments. Moreover, better understanding of the interplay between age changes and disease should benefit younger persons as well as the aged.

For example, cardiovascular diseases (diseases of the heart and blood vessels) are the major cause of death among the elderly. But one-fourth of all victims of heart attacks are under age 65. Exploring the relations of biological change, heredity, and environmental stresses to cardiovascular disease in the elderly may aid in treating, and perhaps reducing, the incidence of the disease in young and middle-aged adults. We know little about the events leading to coronary arteriosclerosis, a disease in which the arterial

*The Old Ship is not in a state to make
many voyages. But the flag is still
at the mast and I am still
at the wheel.*

WALT WHITMAN

to his doctor, after a stroke.

(quoted by Simone de Beauvoir in *The Coming of Age*)

walls harden, thicken, and grow inelastic. Yet the disease is a major killer, and there is evidence from epidemiological studies, including studies of human populations, that environmental as well as genetic factors are involved. A study emphasizing the interplay between biological change, such as hormonal balance, and environment, including diet, may clarify the etiology of coronary arteriosclerosis and help harden hypotheses into facts.

Although it is accepted that several ailments may occur in one person simultaneously, the interaction of these ailments is not always taken fully into account in diagnosis and treatment of the elderly. Metabolic malfunctions, congestive heart failure, thyroid or vitamin deficiencies, drug toxicities, liver and kidney failures—any of these can cause a second illness, organic brain syndrome, which is treatable if the original cause is recognized. Diabetes mellitus, alcoholism, and some malignancies may singly or in combination cause a dormant infection to flare up; because of reduced immunological protection with age, this can result in tuberculosis in an elderly patient. The tendency—indeed, often the need—to treat multiple disorders with multiple drugs commonly results in overdosages and toxicities, an added spur to research on the multiple nature of geriatric disease.



An intriguing characteristic of the diseases of the elderly is that their expression often results from the interplay of biological changes of aging and disease processes. Understanding these interplays should enable us to improve medical care for the aged; further, by examining the way changes are expressed in illness, we may gain insights into the changes themselves.

The interaction of aging and disease is evident in various groups of diseases. There are diseases whose incidence with age has shifted to include more of the elderly; for example, rheumatoid arthritis, whose severity, in rapidity of onset and effects on joints, may depend on normal physiological changes with age in bone mass and connective tissue. Some diseases are almost unique to the aged. An example is accidental hypothermia, a growing inability with age to cope with cold temperatures coupled with other factors, it can cause a person to become so

Whenever we do achieve a genuine insight into a particular disease, deep enough so that we can figure out what to do precisely for prevention or cure, the measure turns out to be both simple and inexpensive Meningitis, polio, subacute bacterial endocarditis, neurosyphilis, scarlet fever, and diphtheria in no sense represent economic problems today. Where we run into the insupportable costs and unbearable technologies is in the care of those diseases by which we are still mystified.

LEWIS THOMAS, in *The New York Review of Books*

insensitive to drastic falls in temperature that he may freeze. Finally, some diseases take a different form in old age. Among these are tuberculosis, diabetes mellitus, infective or bacterial endocarditis, (inflammation of heart membranes and connective tissue), and thyrotoxicosis (a disease of the thyroid gland).

The physician who is unaware of the effects of altered physiology on symptoms can be deceived. Changes in renal clearances—the removal by the kidney of substances from the blood, including sugar—can result in little or no sugar in the urine of the elderly diabetic; therefore, his condition may be misdiagnosed. A test for one variant of tuberculosis may be negative in the elderly. The sensitivity to pain is often markedly different in the elderly, hence the painless coronary thrombosis, the silent intestinal obstruction, or the lack of localized pain in acute appendicitis.

The symptoms and courses of such illnesses in the elderly are often described as unconventional and atypical. But what is unconventional is that symptoms differ from those in the young. Research is needed to link the bodily changes of aging with the expression of illness not because aging is the cause of these illnesses (there is no evidence of that) but because it determines their nature.

A remarkable advance in biomedical research on aging has been the measurement of the physiological and structural changes that occur with age. Although most of these changes have been measured only in men, and none of them occurs in any sort of lock step fashion, varying by individuals and by the particular changes measured, some general trends of aging do emerge. Muscles lose some of their elasticity. The senses blur, with

consequent changes in sensitivity to light, noise, odor, and pain. Blood pressure rises and glucose tolerance declines. Body composition redistributes, with the proportion of protein going down and that of fat going up. Electrical patterns in the brain change, the dominant electroencephalographic rhythms slowing with age. Possibly because of the loss of nerve cells, the elderly are often less sensitive to thirst; they may become dehydrated, then confused and constipated—simply because they lack thirst cues and are therefore not drinking enough liquids.

Immunity and Aging

New insights into biological processes become part of aging research when scientists ask how such processes change with age. This has happened in studies of immunity, the body's recognition of and response to foreign molecules. Older people are more prone to secondary infections, antibiotics are often less effective, and fever is a less reliable signal of infection.

Our understanding of how the body's immunological system works is incomplete. But we do know that it is composed of several different parts (lymphocytes, immunoglobulins, macrophages, complement); that its effectiveness depends on the interactions of several different types of cells; and that, unlike other organs, the immunological system is diffused throughout the body, a characteristic necessary to its role of finding, identifying, and inactivating foreign molecules.

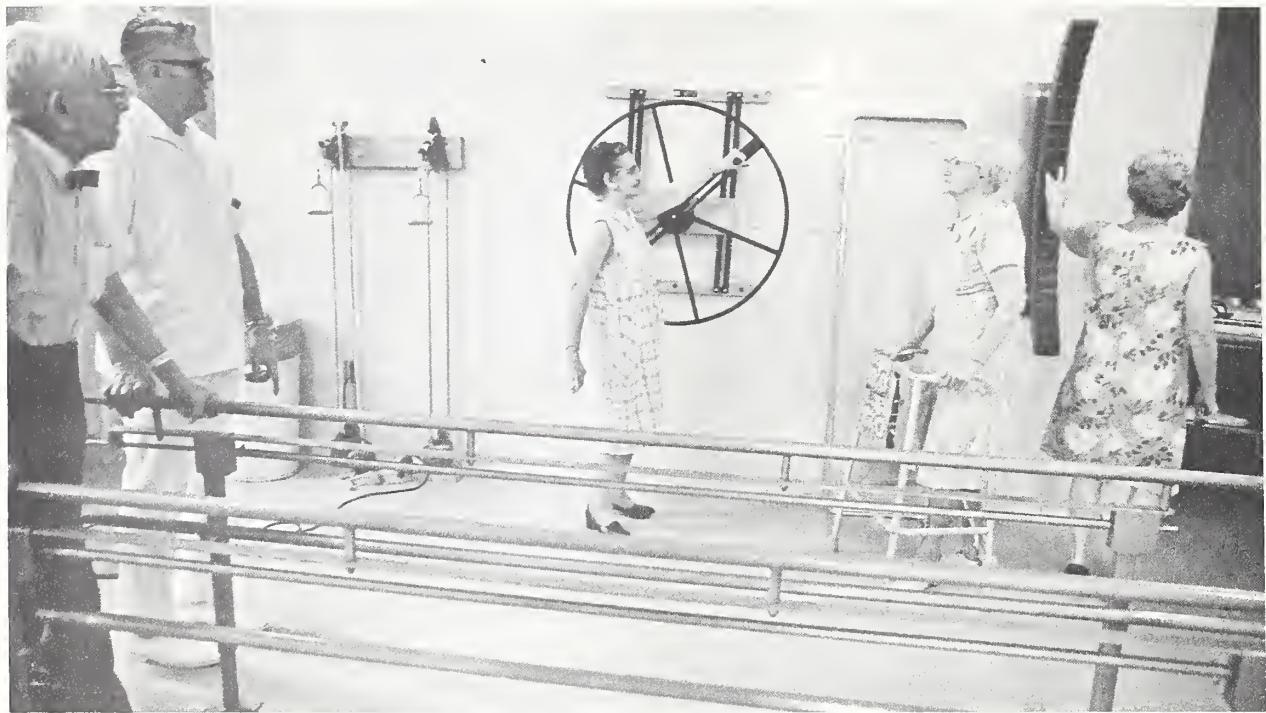
The two great arms of the immunological system are the B and T cells, both arising, in vertebrates, from stem cells in bone marrow. After contact with antigens, B cells become plasma cells, from which emerge five classes of immunoglobulins. The proteins, because



of their ability to react with the antigens, are called antibodies. The role of T cells, or T lymphocytes, is more complex: Some cooperate with or help B cells in synthesizing antibodies; some suppress antibody synthesis; some are directly involved in cellular responses, as contrasted with antibody responses (that is, cell-mediated immunity rather than antibody-mediated immunity).

Cell-mediated immunity is apparently involved in physiological responses to viruses, fungi, mycobacteria, and some tumors; it also seems to be involved in both graft rejection and hypersensitive reactions of the skin. Antibody-mediated immunity is involved in protection against various viruses, bacteria, bacterial toxins, and, possibly, some tumors.

There are changes in T and B cells with age: T cells proliferate more slowly and their numbers decline; antibody production, indicative of B-cell activity, declines. What these changes signify is uncertain, but it is tempting to ascribe many of the changes associated with aging to changes in immune



functions. Immunological changes are double-edged, marking not only a decline in the body's defenses, but also an increasing likelihood that the various parts of the immunological system may attack the body itself, provoking autoimmune diseases.

Individual environmental and genetic factors in concert with immunological changes may lead to diseases such as cancer, but there is no clear evidence of that. It is clear that specific, fundamental changes in the immunological system occur with age and that these changes offer possible insights into disease. Further work is needed to relate suspected causes to actual effects.

Drugs

Research on developmental changes with age should improve the use of drugs—increasing their effectiveness and reducing the risk of toxicity through overdosage.

How a drug behaves in the body is described as its pharmacokinetics: the drug's absorption into the bloodstream, its distribution to various cells, its metabolism into other forms in the liver, and its eventual excretion, usually through the kidneys. The body's functions are affected by aging; as a result, pharmacokinetics are affected. For example, the concentration of a blood protein, serum albumin, declines with age. The distribution of many drugs is dependent on their attachment to albumins; with a lowering of protein concentrations, there are changes in drug binding and, consequently, in drug distribution. Distribution is also affected by the higher ratio in the elderly of fat to protein, which increases the storage room for fat-soluble drugs. The filtering powers of the kidneys and the ability of the liver to detoxify drugs such as barbiturates also decline with age, a change even more

telling when two or more drugs are taken at the same time. A drug such as lithium carbonate, given for some mood disorders, may stay in the elderly body twice as long as in a younger one because of the declining filtering capacities of the kidneys. The electrical activity of the heart changes with age, changing the heart's responsiveness and sensitivity to drugs. The sensitivity of the adrenal cortex to ACTH also declines with age.

Drug dosages appropriate for the young may be inappropriate, even harmful, for the elderly. The concentration of a given drug in the blood may be a deceptive measurement: the drug, rather than being bound to plasma proteins, may be stored in fat depots. Attempts to increase the concentration of the drug in the blood without taking into account these stores in the fat may lead to serious overdosages. Similarly, failure to allow for the declining ability of the liver to detoxify drugs may lead to serious side effects—to iatrogenic illness, that is caused by the treatment itself.

Nor can drug effects be generalized. Cigarette smoking, as well as age, affects the removal by the kidneys of the analgesic (pain killer) antipyrine, although caffeine seems to have no effects.

It is particularly important to describe the action of those drugs commonly used to treat geriatric problems. Studies being done in Britain, Australia, and Japan, as well as NIA studies, are contributing some information on pharmacokinetics in the elderly, but progress will depend on fundamental advances in biology. For example, researchers at the National Institutes of Health and elsewhere have established that polypeptide hormones such as insulin, in contrast to most steroid hormones, induce cellular changes by binding to sites on the cell surface called recep-

tors. Moreover, in maturity-onset diabetes, there appears to be an inverse relationship between insulin concentration in the blood and the number of receptors on target cells; that is, if insulin concentrations go up, the number of receptors declines. The relationship is apparently dependent, in part, on diet. This finding, besides providing an insight into a particular illness, further certifies the relation of environment—in this case, diet—to disease: changes in nutrition can apparently change both hormone concentrations and the receptivity of cells to hormones.

Other age-associated changes in number of receptors are being documented: for example, declines with age in the number of receptors on heart muscle cells for catecholamines, which are secreted under stress and which trigger the contraction of heart muscle. A working hypothesis now being tested

is a possible loss with age of receptors for digitalis, a drug used to treat various cardiovascular disorders, including congestive heart failure. Cardiac arrhythmias and neurological disturbances have been reported in elderly people given digitalis dosages that do not appear to injure younger adults.

Are such receptor changes intrinsic to aging? Are they partly environmentally induced, as changes in insulin receptors appear to be? Or do normal aging and environmental factors act together to cause receptor changes?

The work of cell biologists on the role of receptors can help researchers on aging gain an understanding of how cells work, a clearer idea of the nature of aging, and, clinically, a more knowledgeable use of drugs, not only for the aged, but for everyone.

The Aging Mind

Old people who are mentally ill are major clients of the health and social services of the developed nations. Some 15 percent of the elderly in the United States—slightly more than three million—have mental disorders; five percent, severe disorders. And, while the elderly constitute about 11 percent of the U.S. population, they account for 25 percent of all suicides.

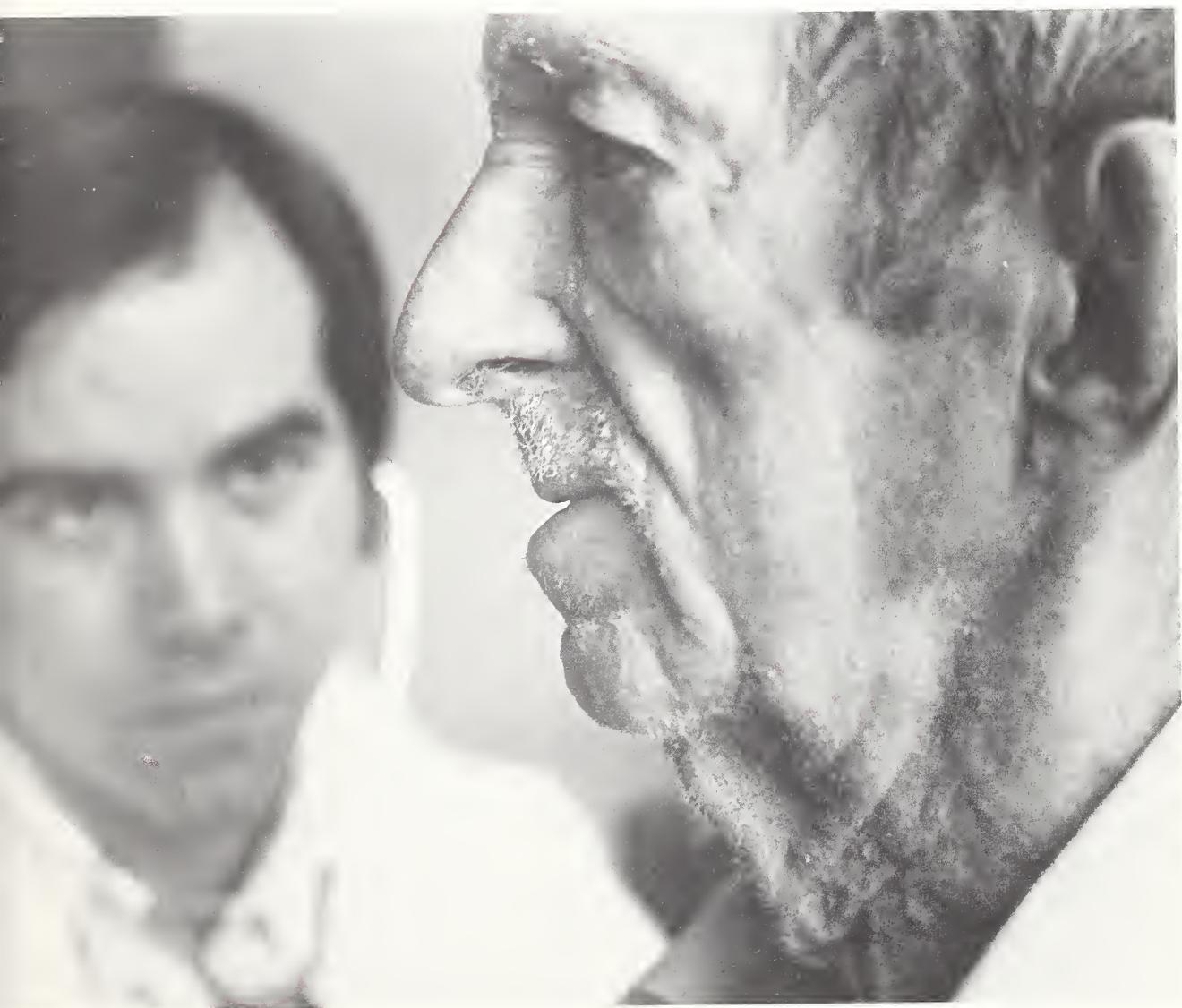
The statistics underline the importance of the questions now being asked about the mental illnesses and mental abilities of the elderly. What mental illnesses are more common to the elderly and what are their causes? Which of these are curable and which can be mitigated? Which are the result of emotional stresses? Which of physical illness? Which of both? What is the optimum way to treat various mental disorders in the elderly, as contrasted to comparable disorders in younger adults?

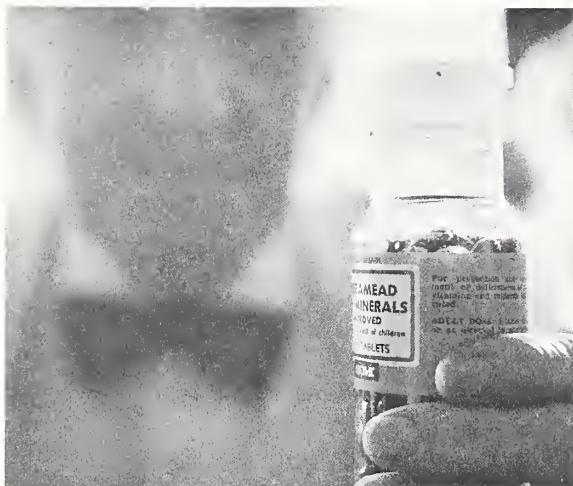
Mental illnesses of the aged are either functional, organic, or a combination of the two. Functional illnesses, such as most depressions, are caused by emotional stress; organic illnesses, by physical impairment, such as cerebral arteriosclerosis or drug intoxication. Most of the functional disorders are curable; some 15 percent of the organic disorders are.

The agenda for research is considerable. For example, we need more information on the relationship between physiological changes and brain functions, and between physical illnesses and mental confusion. Also, to understand the abnormal, we must understand the normal: to understand mental illness in the elderly, we need measures of normal ranges of mental capacities and abilities among the aged.

*Atypical presentation of illness is the bait
which lures the clinician to study
and enjoy the clinical care
of his elderly patient.*

SIR FERGUSON ANDERSON





*There must be a diseased mind, where
there is a failure of memory at seventy.
A man's head, Sir, must be morbid
if he fails so soon.*

SAMUEL JOHNSON in Boswell's *Life*

The aging brain seems more vulnerable to anoxia (lack of oxygen), low blood pressure, and low blood sugar. These vulnerabilities are still poorly understood, and consequently their role in mood changes and mental illness is not always apparent—to a victim's family, friends, sometimes even his physician. We also know that many organic brain syndromes are due to some particular malfunction: congestive heart failure, thyroid or vitamin deficiencies, liver or kidney failures. What are the actual relationships between organic brain syndromes and these physical impairments? What insights do these offer not only into the more subtle ramifications of these diseases but also into developmental changes in brain function?

II The Aged in Society

*Do not imagine, because I am silent,
that I am not present,
and alive,
to all that is going on.*

Mrs. Rooney in *Krapp's Last Tape*
by SAMUEL BECKETT

How do the elderly maintain themselves? Elderly widows and couples? Urban and rural elderly? Well-to-do suburban white and poor, inner-city black? What perceptions do different groups of the elderly have of their lives—of their health, of their status in society, of their links to younger people? How are these perceptions formed and what do they imply about the services needed by the aged? How do these perceptions square with their needs as seen by others? How does the pattern of his or her life prepare the individual for retirement, for the change in income and often in status that may accompany it? How does the individual who has worked for 30 or 40 years find new values to replace the economic ones?

Research on such issues will aid federal, state, and local governments in assessing and refining income-support programs for the elderly—social security benefits, Medicare

and Medicaid, the Supplemental Security Income program, welfare programs. Research will also help society integrate the needs of the aged, now and in the future, with its efforts to provide housing, transportation, delivery of medical care, and other services.

Attitudes

Infusing these and other issues pertaining to the aged in society are attitudes toward the aged and aging—attitudes of the aged themselves and of the younger population. Prejudice against the aged—ageism—is displayed in several ways: in our obsession with youth (although that may wane as the average age continues to rise); in the emphasis by the media on extraordinary achievements of the aged, rather than on their ordinary, often satisfying lives; and in the poor general understanding of the values of old age.

Anthropologists have found that the aged are regarded differently in different cultures. Gerontocracies seem to be the norm in traditional, preliterate folk societies. Urbanization, industrialization, and increased mobility may have been among the elements that reduced the significance of gerontocracies and lowered the regard for old age. Continued cross-cultural research should further illuminate these elements, which are disputed. But the point is that the views of the aged widely held in Western societies,

In their seventies or eighties, with long memories of hardships faced and perhaps only partially (if at all) surmounted, 'deprived' of education, made to feel hopelessly inarticulate, and obviously out of 'the American mainstream,' they are nevertheless men and women who seem to have held on stubbornly to a peculiar notion: that they are eminently valuable and important human beings, utterly worth the respect, even admiration, not to mention the love, of their children and grandchildren.

ROBERT COLES, on the Chicanos of New Mexico in *The Old Ones*





....the basic flaw in the view that earnings and human worth are synonymous turns on the assumption that a person is of no consequence, save for the work he does; that his economic value (whatever someone will pay him to work) is the full measure of the human being. On reflection, we readily admit that such an appraisal grossly understates the sum of the qualities that make up an individual. Yet the habit persists

JUANITA KREPS

including the notion that the old are useless, are not shared by other societies. Biases toward the old are not inevitable; rather, they are shaped by various, only partly known forces.

Values

One element in our attitudes toward the elderly and toward becoming old is the economic valuation of human worth: how much money a man makes, how big his house is, how much money his material possessions cost. In retirement, income drops markedly for most Americans. And there may be a false perception that, with retirement, one's income is no longer determined by work, but by pension policies. Such changes—in level and source of income—may result in a loss of esteem, both among the elderly and by the younger population.

Economic hardships and shocks do await many after they retire, and research is needed to accurately portray these problems. Men over 65 on the average have less than half the income of men ten years younger; there are comparable differences between women over and under 65, although the amounts and gaps are somewhat less. There is an 18 percent drop in per capita income in families where the head is over 65, a somewhat sharper drop for black families, and a drastic drop for black families headed by women.

The costs to the aged of maintaining a tolerable standard of living—a standard defined by their own histories, cultures, health, and social settings—are not known. Incomes adjusted to the Consumer Price Index, while allowing for inflation, still may not reflect the special problems of the aged.

Dependency

Research on the economic status of the aged may help illuminate the support needed

by different groups of the elderly and society's ability to meet those needs.

The first issue, what the aged require, demands a careful and thorough analysis of the independence of various elderly groups—the degree to which they can care for themselves, either alone or with minimal help. We can surmise from available data that three to four million elderly persons—out of 23 million—need some help from families, friends, and social services to do the routine tasks of life. Some one million of those aged needing help are in long-term care institutions, mostly nursing homes. Since residents of nursing homes are a "captive" audience, they are relatively easy to study, and considerable data are available on them. But what of those elderly who live alone or with relatives or friends? What are their needs? What mix of services would serve the largest number? What services are now available? In what way can governmental programs help match services to needs?

Retirement

What are the effects of current retirement policies and trends on income maintenance programs such as social security, Medicare, and Medicaid? For example, one way to balance social security income and payments (other than raising payroll withholdings) is to raise the usual retirement age of 65. But the trend is toward retirement before age 65 and toward fewer persons age 65 and over working or seeking work: of men over age 65, 22 percent work today; by 1990, the figure is expected to be 17 percent. These percentages become considerably more significant when broken down: for example, in 1974, 48 percent of the men over 65 who had five or more years of college were still working; only 12 percent of men over 65 who had less than five years of elementary

education were working. Earlier retirement and increasingly later entry into the work force by the young are lowering the number of years worked. As a result, amount of social security taxes paid is reduced (unless rates are raised), earned interest is reduced, and years of payout are increased.

Research on retirement includes an examination of how retirement is perceived, by both those who have retired and those who are approaching retirement. The conflicting data on whether retirement is or is not welcomed by most retirees should be examined. How do their views change after five or ten years of retirement? What effects does approaching retirement have on individuals, including their relationships with their families and colleagues? How does retirement affect health? What are the psychological and social effects of losing training opportunities, merit increases, and promotions as retirement nears?

In probing the issue of dependency—analyzing the relationship of income to need, the services needed by those aged unable to care fully for themselves, retirement policies and their effects—we should emerge with a clearer view of what aging is and is not in the United States.

*... The good
And evil of my history
Go by. I can see them and
Weigh them. They go first, with all
The other personal facts,
And sensations, and desires.
At last there is nothing left
But knowledge, itself a vast
Crystal encompassing the
Limitless crystal of air
And rock and water.*

From "Time is the Mercy of Eternity" by KENNETH REXROTH
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But I very well understand that {the vigor and gaiety of my life} is a commodity hard to recover: by weakness and long experience our taste is becoming more delicate and nice; we ask most when we bring least, and are harder to choose when we least deserve to be accepted; and knowing ourselves for what we are, we are less confident and more mistrustful; nothing can assure us of being beloved, considering our condition and theirs. I am out of countenance to see myself in company with those young wanton creatures.

MONTAIGNI

Life means exposure to stress—physical stress, such as exposure to harmful industrial chemicals, various diets, cigarette smoking; psychological stress, such as the death of friends, husbands, and wives; social stress, such as job pressures and economic difficulties. And stress appears to have an important, at times determining, effect on a person's health. But the effects of stress remain poorly analyzed and quantified, largely because isolating them is as complex a task as it is necessary. The problem is not simply one of method—of arranging studies of people over some period of time—but also of clearly distinguishing the effects of stress from the effects of inheritance, disease or simply accidents. Discerning subtle changes over time is the motive of aging



research and it is from that perspective that researchers are making initial, tentative connections between stress and health. For example, stress leading to continued anxiety and depression seems to disturb the neuroendocrine system, which regulates blood pressure. High blood pressure (hypertension) is a possible result, as are increased susceptibility to strokes (cerebrovascular accidents), myocardial diseases and kidney failures.

Stress is often subtle. How telling on different individuals with different genetic backgrounds are the stresses of urbanization? Of industrialization? Of changes in the patterns of family life? Of living in ghettos? And of the anomie that afflicts persons in a society with rapidly changing values?

That we can't answer these questions doesn't lessen their importance, not only for the aged but for all of us. Environmental stress seems to have some role in the two most common killers, cardiovascular disease and cancer, probably undetected involvements with others.

Stress occurs more frequently among the aged simply because some causes of stress are more common among the aged. They are more likely than younger persons to suffer the death of their contemporaries; isolation from family and community; illness; sensory deficiencies; forced retirement; inadequate income; and other stresses. What is remarkable is the strength and capacity to deal with such stresses displayed by many of the aged.

Research may find ways for society to bolster an elderly person's resistance to stress or his ability to deal with it. And in studying stress among the aged, its relationship to health and well-being, we may all benefit.



Methods

Some typical questions for research have been described, many of them are now being addressed by the NIA, or are on its agenda for future programs. Most of these questions are not new. What is new is that, for the first time, many of them are answerable. The reasons for past indifference by many to the plight of the aged are complex, composed of misunderstandings, fears, obsession with youth, changes in family structures, changes in society. The reasons for the past reluctance of many researchers to enter gerontology (the study of aging) and the reasons for the slow progress of those who did are simpler: lack of techniques and experimental models—including populations of aging animals and humans—and often low funding.

The researcher who wishes to study how people change with age—biologically, socially, or behaviorally—has a formidable task. Studies of human populations are *never*

easy: the population to be studied must be sufficiently large for worthwhile results; massive amounts of data on genetic and environmental histories must be collected, collated, evaluated, and correlated; and the researcher and his colleagues must hope that they and the population under study stay together long enough for useful results to be obtained.

Studies of *aging* populations face further challenges. A researcher in child development can be reasonably certain that his study period is limited to perhaps a decade, that the experiences of his subjects are also limited, and that their family histories are obtainable. He can expect, in time, results and publications. The researcher in aging not only contemplates a research effort that may last decades, but also lifetimes of experiences to consider and assess—medical histories; diets; marriages, successful and failed; children and parents' hopes for them, realized and unfulfilled; jobs and their stresses; deaths and their effects. Even researchers interested in the most fundamental aspects of human aging must take account of these experiences. The theoretical life span of human beings (indeed, all species) is genetically controlled; but its expression—how long people actually live—is modulated by individual history. And the elements of that history are all variables that may or may not have an influence on aging. The researcher must design a protocol in which he or she can, in a convincing fashion, sort out the elements related to aging from those that are not. That is not simple. Researchers on aging have often tended to use age as an index of all changes observed over time, regardless of whether aging caused or simply paralleled the changes. The result is a vast amount

of information, but much of it is poorly categorized.

The difficulties of studying age-related changes—whether in population studies, as briefly described, or in other ways—have forced two axioms on any research program: (i) questions must be reduced to researchable proportions, to a level susceptible to experiment, to hypotheses and their testing, to workable field studies, to sound demographic analyses; and (ii) all results must be treated circumspectly, in full recognition that they show only a part of the whole, at times a very small part. Exaggerating research findings not only may be misleading, but may also, if applied, result in poor policy.

The posing of answerable questions has been made more practicable by the availability of new animal models; by studies of human populations that, while still plagued with methodological faults, have produced useful information for guiding future studies; and by remarkable advances in other sciences.

These advances have sharpened the sophistication of the questions asked and the rigor of experimental designs. Biological issues in aging have been infused with new vigor by research in molecular and cellular biology. Molecular biology has provided an understanding of how proteins are made within cells and how genetic traits are stored and transmitted. Work in cellular biology has clarified the interactions of the various organelles of the cells, the critical role of cellular membranes, and the controls on cellular division and replication.

Such progress can help researchers probe the body's riddles, such as the differential aging patterns of the body's levels of organization ranging from molecular processes within a cell, such as protein synthesis; to

cellular organs, such as mitochondria, which provide the energy to drive the cell; to organ systems, such as the cardiovascular system or the interdependent endocrine or hormonal networks. Although each of these levels seems to have its unique aging pattern, a logical hypothesis is that they are interrelated. The aging of an organ—for example, the changes over time in the liver's ability to detoxify drugs—may be related to changes in the different types of tissue that compose the organ, which, in turn, may be dependent on age-related changes in the cells of these tissues. How a cell ages depends upon whether it is a somatic or a germ cell, or a dividing or non-dividing cell. Organs age differently, according to whether their cells can replenish themselves (such as those of the skin) or are irreplaceable once lost (such as those of the brain).

These are statements about relationships, *not* about cause and effect. One practical tactic for learning what *is* going on is to enter by the most basic route available: the insights and techniques of molecular biology. The gerontologist working on the level of molecular biology may follow changes in the efficiency of a particular enzyme over time, perhaps asking how the rate of the enzyme-controlled reaction changes under various stresses. Or he may follow changes in genetic regulation: are on-off mechanisms changing over time? Are more mistakes made in the proteins synthesized by older cells? If so, what is (or are) the source of these mistakes? Are they related to changes in the structure of the DNA molecule (where genetic information is stored), changes in the passing of the information from DNA to RNA, or mistranslation of that information by ribosomes (the cellular units of protein synthesis)?

Models

Molecular biology has aided the researcher interested in aging in another, partially psychological way: by establishing the fundamental genetic unity of all living organisms. All living creatures (aside from some viruses that use RNA) rely on the same type of molecule, DNA, to encode the information by which they develop and are able to transmit their traits to their offspring. Moreover, the way DNA is expressed—how its information is used to make enzymes and other proteins needed by the working cell—is essentially the same in all creatures, although there are some important and not fully understood regulatory differences between DNA expression in bacteria and in human cells.

But the fundamental genetic unity has been established, and it justifies the use of very simple creatures, such as micro-organisms, in investigating the biological, genetically-controlled elements of aging. Micro-organisms, such as amoeba, and some invertebrates and plants are also useful in aging research because they depend on an external environment, which can be controlled by the researcher. Studies of these simple systems may help settle some questions about how environment affects the expression of the genetic program for life span. For example, the ciliate *Tetrahymena*, which can be grown in large amounts in media and whose nutritional needs and metabolism are known, has the same amino acid requirements and similar vitamin requirements as men and rats, making it useful for the study of the relation of dietary changes to aging.

Insects are also useful: their habits are diverse; their habitat encompasses every sort of climate; they are short-lived and fecund;



and their maintenance is generally low in cost and space demands. Specific questions can be asked and results obtained within a reasonable time.

Primates, rats, mice, dogs, and pigs make good experimental models because they are the closest to human organisms. But their evolutionary complexity makes the interpretation of results more difficult and often ambiguous; for instance, the life span of these animals is very dependent upon their diets, which must be carefully monitored to ensure that results ascribed to aging are not really due to nutrition.

Whole organs can be and are being studied, the generic difficulty being that

organs are composed of tissues of different types of cells, and that each type of cell ages differently. Mammalian cells can be cloned in tissue culture. (A clone is a mass of genetically identical cells grown from a single cell). Tissue cultures have been used to analyze the effects of aging on mitotic, or dividing, vertebrate cells. Patterns of growth of mammalian cells in culture have been related to various environmental influences, such as changes in the mix of nutrients.

Human Studies

There are two principal ways of using human populations to study aging: (i) cross-sectional studies, in which cohorts are compared (a cohort is a population of roughly the same age and cultural and social background); and (ii) longitudinal studies, in which changes with age in the *same* population are tracked. Each has its problems. Cross-sectional studies are, in principle, less difficult, since they are not premised on a long-term commitment by the investigator. However, it is often difficult to tell what is being measured when cohorts of different ages are compared: whether, for example, differences in the ability to assimilate new information are due to differences in cultural and educational experiences or to differences in age. Cross-sectional studies tend to emphasize group differences rather than individual differences; differences between individuals within a cohort tend to be smoothed out, even though these intracohort differences may be greater than differences between individuals in different cohorts.

Longitudinal studies, which implicitly analyze the *processes* of aging, emphasize individual differences and focus on variables in individual lives that result in different patterns of aging. Longitudinal studies have the problem of selective dropout: the loss of individuals through death or withdrawal, and the likelihood that those remaining are increasingly unrepresentative of the original sample.

Other sampling problems are shared by cross-sectional and longitudinal studies: the number of people in the study population is often too small and may fall below the useful level if the dropout rate is high; and the selection of subjects is often determined by availability rather than by rigorous sampling techniques.

These problems are recognized. And when proper allowances and careful assessments are made, both cross-sectional and longitudinal studies can offer valuable insights. They may, in time, solve some puzzles, such as the demographic meaning of the higher death rates among elderly men than among elderly women, or the relationship between arteriosclerosis and aging. Studies of human populations may help explain the relationships of a lifetime's diet to general health and to particular diseases; the ties between the stresses of life and physical and mental health; or the relationship between a person's adolescent and adult experiences and his ability to cope with the severe stresses of old age—loss of the calming routine of a job, loss of a wife or husband, chronic illnesses that are manageable but not curable.

Afterword

This publication has briefly outlined the problems of the aged and the research issues arising from them. Underlying these research issues is a spirit of excitement, as needs, methods, and insights converge—needs as most clearly illustrated by the rising proportion of the aged in our population; new methods as we improve our abilities to mount and maintain studies of aging human populations; and new insights as we apply fundamental research in many disciplines to sharpening our questions about the last stage of human development.

The goal is to better the lives of the aged, now and in the future. Discovery, development, and dissemination of new knowledge—the mission of the National Institute on Aging—is one approach to that goal. But research must be joined by two other strategies. One is improving the social and economic conditions of *all* the aged to the point where they can thrive, not just survive. The other is a reformation of values: a replacement of the fears of old age and the frequent hostility toward the aged by an understanding of the rich perceptions and continued creativity that can be integral to growing old.

In 1974 the Research on Aging Act was signed into law. This legislation authorized establishment of the National Institute on Aging to "conduct and support biomedical, social, and behavioral research and training related to the aging process and the diseases and other special problems and needs of the aged."

The NIA's programs fall into two general categories: intramural research that is conducted at the Institute's laboratories in Baltimore, Maryland, and extramural and collaborative research and training which is research supported through a variety of grants and contracts to universities and nonprofit medical centers across the country.

New knowledge and fundamental understanding gained through research is the ultimate service and the ultimate means of cost containment. Without new knowledge through research, we will continue in our old ways at ever increasing costs.

If you are interested in research in aging or receiving training for a research career, please contact the Institute for further information.

NIA Information Office
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If your institution does not have NIH grant application kits, one may be obtained by writing to the following address:

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Division of Research Grants
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National Institute on Aging

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